DAMAGE TO PEANUTS FROM FREE-FALL IMPACT

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DAMAGE TO PEANUTS FROM FREE-FALL IMPACT

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ABSTRACT

Shelled and inshell Runner, Virginia, and Spanish peanuts were free-fall-impacted upon wood, steel, concrete, and peanut surfaces. Drop heights ranged from zero to 12 feet for the shelled peanuts and from zero to 45 feet for the inshell peanuts. Tests were conducted under two peanut temperature conditions, 74° to 76° F and 35° F. The damage factors measured and used to define results with the shelled peanuts were split kernels, oil stock, bald kernels, and germination. Split kernels, foreign materials, loose shelled kernels, cracked or broken pods, and germination were used to define results with the inshell peanuts. Drop heights of 2 feet and above were highly significant as a cause of damage to the shelled peanuts. In some of the tests with the inshell peanuts, significant damage occurred when drop heights reached 8 feet. There was interaction between drop height, impact surface, and peanut temperature in some, but not all, tests. For the shelled peanuts, the percentage increase in split kernels was higher than the increases in any of the other types of damage. With the inshell peanuts, the percentage increase was highest for the cracked or broken pods but was almost as high for the loose shelled kernels. The amount of damage that occurred in a particular category varied with peanut type and test condition.

INTRODUCTION

Peanuts go through many handling and processing operations before reaching the consumer, and they are repeatedly subjected to impact forces from being dropped or from mechanical equipment. Though the peanut industry recognizes that peanuts are damaged in handling and in processing, there is very little information available that defines the type or extent of damage done or that relates it to drop height and impact surface.

Experiments were conducted to determine the amount of various types of peanut damage caused by free-fall impact of peanuts upon surfaces of different materials. Shelled and inshell peanuts at 74° to 76° F (ambient air temperature) and at 35° F were dropped upon surfaces of wood, steel, concrete, and peanuts. Drop heights ranged from zero to 12 feet for shelled peanuts and from zero to 45 feet for inshell peanuts. Three replications were made at each drop height. This report describes the procedures and results of these experiments.

PROCEDURE

Runner, Spanish, and Virginia peanuts were free-fall-impacted upon surfaces of wood, steel, concrete, and peanuts. Shelled and inshell peanuts were tested at peanut temperatures of 74° to 76° F and 35° F.

The test apparatus consisted primarily of a sample-holding tube with an electrically activated drop gate, a 12-inch-diameter tube (through which the peanuts were dropped), a padded catch box, photoelectric cells, and an electronic timer. The impact surfaces were 18-inch squares composed of ½-inch steel plate,

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a 3-inch-thick cast-concrete block, three thicknesses of ¾-inch plywood glued together, and a 3-inch layer of peanuts with a loose covering of gauze.

The electrical circuitry of the system (fig. 1) was arranged so that a switch simultaneously activated the drop gate and timer. A photoelectric cell was focused just above the impact surface so that, upon impact, the peanuts would intercept the light beam and thereby stop the timer. Three replications were made at each drop height and three variables—drop height, impact surface, and peanut temperature—were investigated.

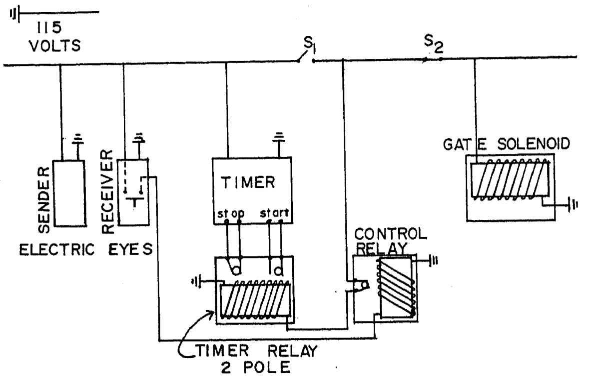


FIGURE 1.—Wiring diagram of test apparatus.

There is some evidence that the velocity of grain falling in a stream is different from that of single kernels falling. Assuming that this would also be true for peanuts, stream conditions were simulated by dropping the peanuts from a 4-foot-long sample-holding tube.

Shelled peanut samples weighing approximately 3 pounds were required to fill a 2-inch-diameter, 4-foot-long sample-holding tube. Ambient temperature averaged 74° F, relative humidity averaged 60 percent, and moisture content of the peanuts was 6.8 percent. Drop [illegible]

diameter, 4-foot-long sample-holding tube. Ambient temperature averaged 76° F, relative humidity averaged 65 percent, and moisture content of the peanuts was 7 percent. Drop heights ranged from zero to 45 feet, and the factors used to analyze damage were split kernels, loose shelled kernels, foreign material, cracked or broken pods, and germination.

Treatment of the test data included an analysis of variance to determine the significance of, and interaction among drop height, impact surface, and temperature. However, in order to show damage as a function of drop height, regression analysis was used to derive equations for the various test conditions. Each equation was derived from the 21 observations made for a particular test condition. Correlation coefficients of 0.444 or greater are statistically significant at the 0.05 level.

RESULTS

Drop height, impact surface, and peanut temperature were all significant causes of damage, but the effects varied according to the type of damage. In all the tests, drop height was the most significant cause of damage, but in most cases the interaction between drop height and impact surface was also significant. Peanut temperature was the least important variable affecting damage.

The amount of damage that occurred in a particular test condition was similar for each of the three peanut types. Therefore, because of the large number of individual conditions involved with all three types of peanuts, the results obtained from the 'Florunner' peanuts are considered typical and are discussed in this publication. The equations for determining the amount of a particular type of damage for each test condition with the Spanish and Virginia peanuts are contained in the appendix. By substituting the appropriate values of drop height (in feet) for X, the damage values in percent (Y) can be determined.

There were slight differences in velocity-and time-displacement values for the three types of peanuts and for the shelled and inshell samples. However, the values shown in the velocity-displacement curve (fig. 2) and in the time-displacement curve (fig. 3) for the 'Florunner' peanuts closely approximate the values for all.

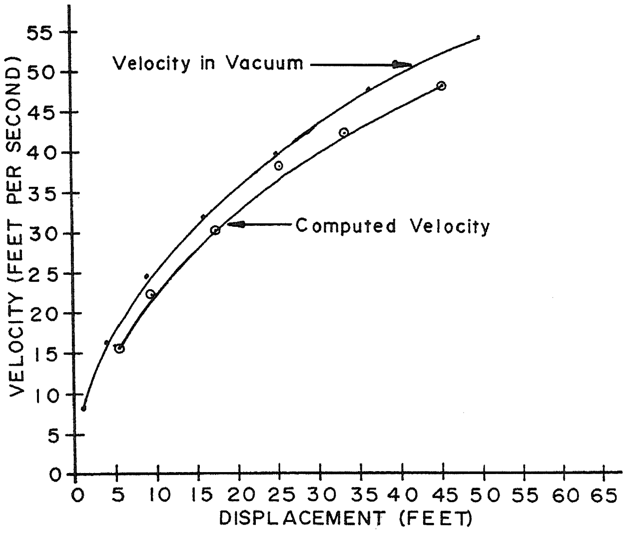


FIGURE 2.—Velocity-displacement curve for 4-foot column of inshell 'Florunner' peanuts in free fall.

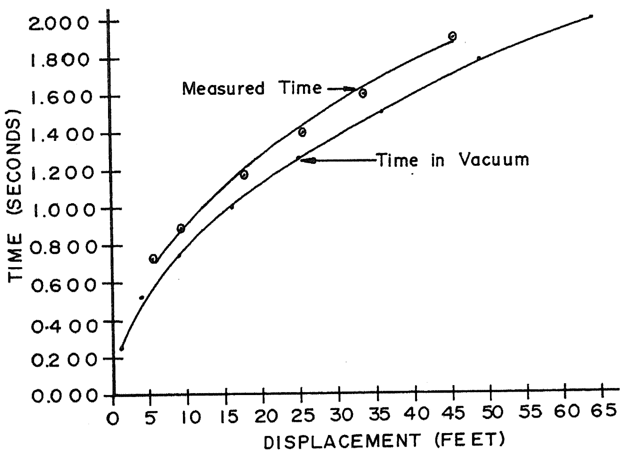


FIGURE 3.—Time-displacement curve for 4-foot column of inshell 'Florunner' peanuts in free fall.

Shelled 'Florunner' Peanuts

Split kernels

The peanuts were more susceptible to splitting than to any other type of damage. Drop height was the most significant cause of damage. However, there was a temperature effect as indicated by the difference in damage values for the two temperature conditions. The split-kernel values for the peanuts at 35° F were slightly higher than those for the peanuts at 74° F (figs. 4 and 5).

There was very little difference among impact surfaces in the amount of damage done, except for the peanut surface, which caused much less damage. The same pattern of response occurred at both peanut temperatures.

Bald kernels

There was a small decrease in the bald-kernel content of test samples for both peanut temperatures (35° F and 74° F) as drop heights increased (figs. 6 and 7). Undoubtedly, some skinning of the kernels occurred from impact, but apparently most of them were split. Fitting the data to a parabolic curve gives some indication that the bald-kernel content of the peanuts at 35° F was decreasing at zero to 4 feet of drop, whereas the peanuts at 74° F had practically no decrease in this drop-height range. Apparently, the slight difference in damage at the lower drop heights was caused by some loss of resiliency in the peanuts at 35° F. It is difficult to establish the overall effect of temperature

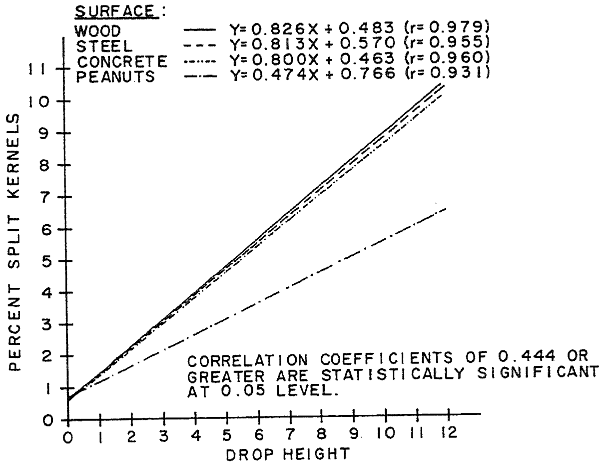


FIGURE 4.—Split-kernel outturn of shelled 'Florunner' peanuts at 35° F after falling from various heights upon different surfaces.

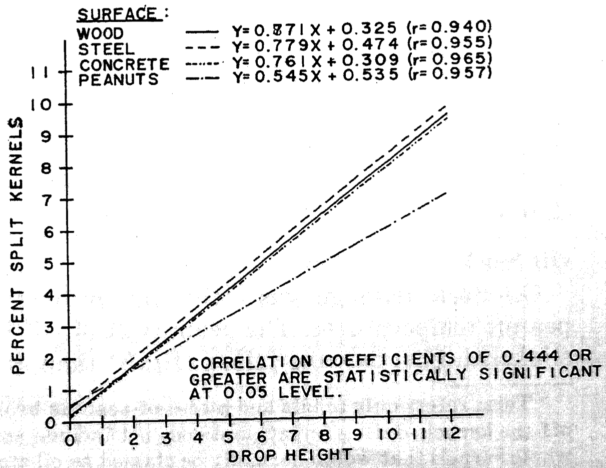


FIGURE 5.—Split-kernel outturn of shelled 'Florunner' peanuts at 74° F after falling from various heights upon different surfaces.

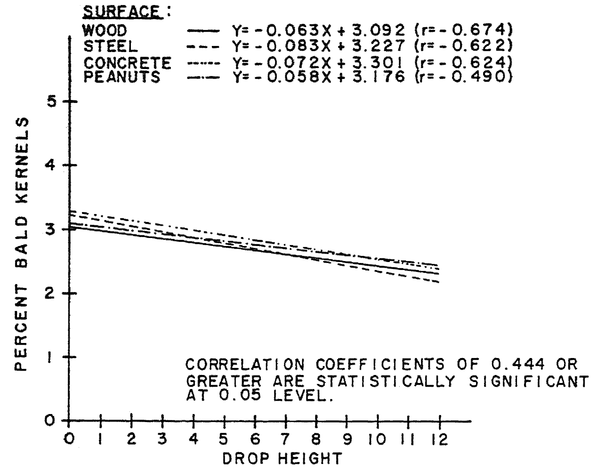


FIGURE 6.—Bald-kernel outturn of shelled 'Florunner' peanuts at 35° F after falling from various heights upon different surfaces.

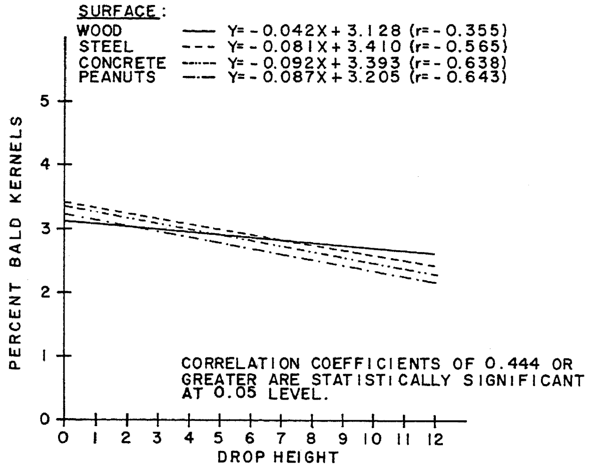


FIGURE 7.—Bald-kernel outturn of shelled 'Florunner' peanuts at 74° F after falling from various heights upon different surfaces.

because of the possibility that many of the bald kernels were split. However, there was very little difference in the response of the peanuts to the impact surfaces. Evidently, when a bald kernel is subjected to an impact of any appreciable extent, it will very probably split unless the impact surface has much better shock-absorbing ability than those used.

Oil Stock

Oil-stock[2] damage was rather minor for both peanut temperatures. The peanuts at 35° F had slightly higher damage values (fig. 8) than those

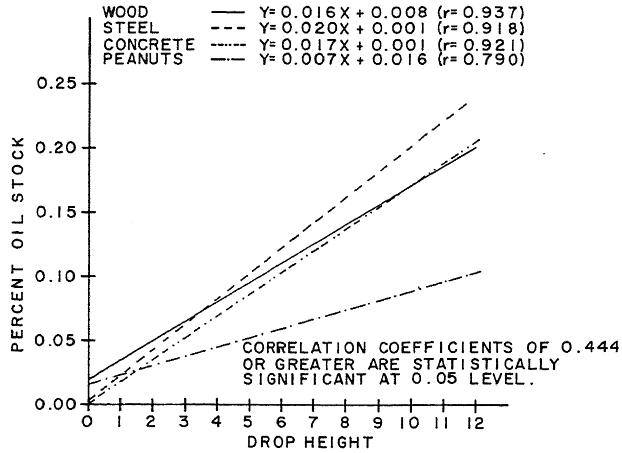


FIGURE 8.—Oil-stock outturn of shelled 'Florunner' peanuts at 35° F after falling from various heights upon different surfaces.

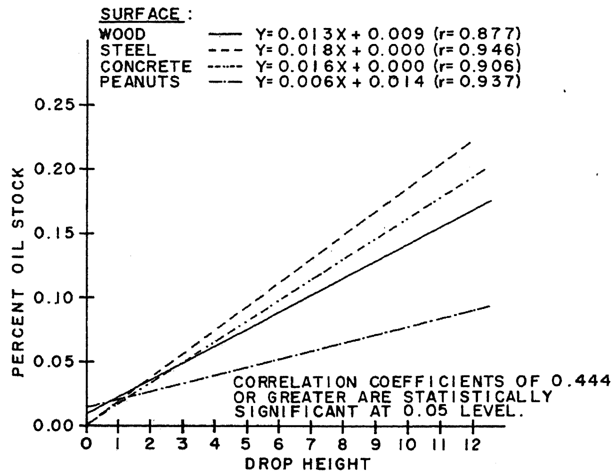


FIGURE 9.—Oil-stock outturn of shelled 'Florunner' peanuts at 74° F after falling from various heights upon different surfaces.

at 74° F (fig. 9), but peanut temperature had less influence than drop height on damage. The reaction of the peanuts to the impact surfaces was similar at both temperatures. The impact of peanuts on peanuts caused the least damage, with the impact on wood, concrete, and steel surfaces next in order. Total damage for the most extreme test condition, peanuts at 35° F impacted from 12 feet on the steel surface, was less than 0.25 percent. Apparently, the peanuts were very resistant to this type damage.

Germination

Germination of the peanuts was very inconsistent and the cause is not readily apparent.

[2] Term refers only to bits and pieces of peanuts broken off the kernels during impact and does not include small whole kernels that would normally be classed as oil stock.

This result was not expected, since in some tests peanut-impact velocities reached 27 feet per second. The control samples had 65 percent germination, and 33 percent of the peanuts were molded. The test samples varied within a few percentage points of the control samples, so perhaps the low germination and high incidence of mold masked or affected some of the damage results.

There was some indication of the effect of drop height when using the concrete and peanut impact surfaces. With these surfaces, and from a drop height of 12 feet, germination of the peanuts at 35° F decreased approximately 6 percent, and those at 74° F decreased approximately 4 percent (figs. 10 and 11). Some effect of temperature may be indicated by this difference in damage.

The germination tests were run in accordance with procedures prescribed by the Georgia State Seed Testing Laboratory. However, it seems likely that some unknown factor affected the results. Therefore, the validity of the data is very questionable.

Inshell 'Florunner' Peanuts

Split kernels

The peanuts at 76° F were more uniform in response and had less damage (fig. 12) than the peanuts at 35° F (fig. 13). Generally, damage values for the 45-foot drop height were 1 to 1½ percent higher for the peanuts at 35° F. At both

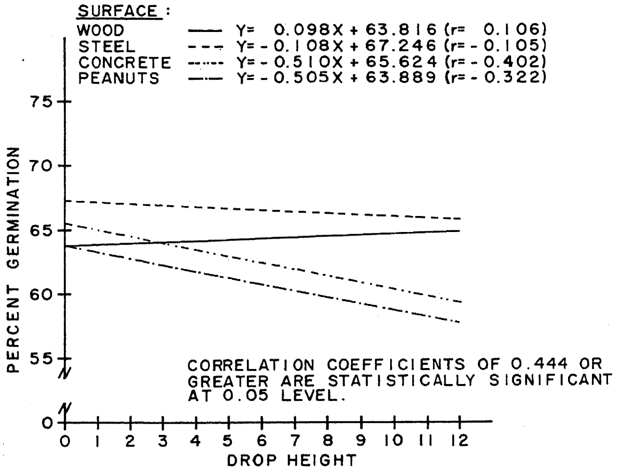


FIGURE 10.—Germination outturn of shelled 'Florunner' peanuts at 35° F after falling from various heights upon different surfaces.

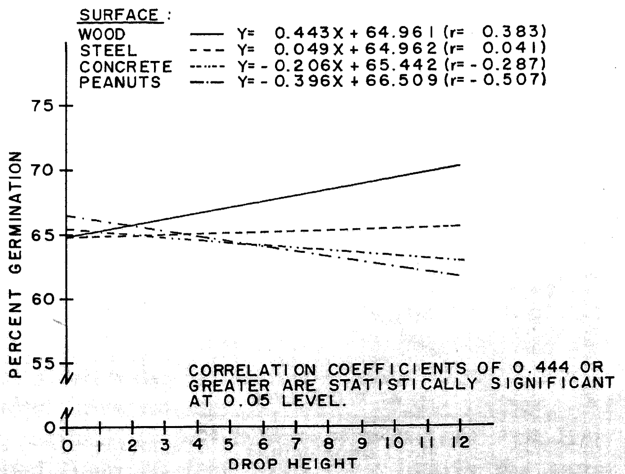


FIGURE 11.—Germination outturn of shelled 'Florunner' peanuts at 74° F after falling from various heights upon different surfaces.

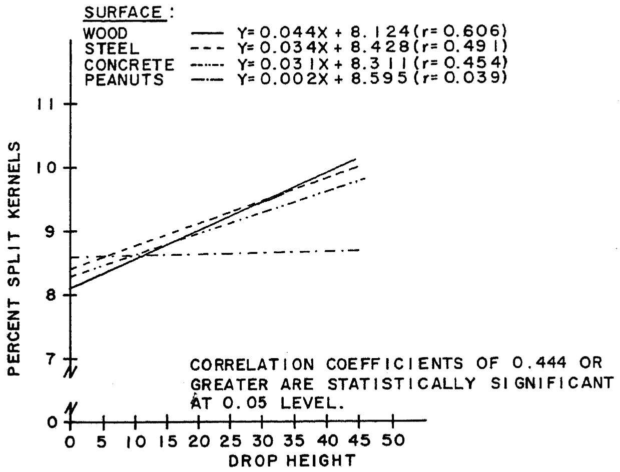


FIGURE 12.—Split-kernel outturn of inshell 'Florunner' peanuts at 76° F after falling from various heights upon different surfaces.

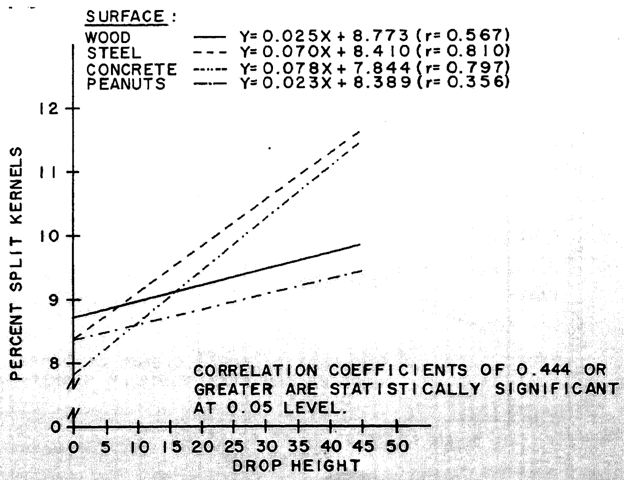


FIGURE 13.—Split-kernel outturn of inshell 'Florunner' peanuts at 35° F after falling from various heights upon different surfaces.

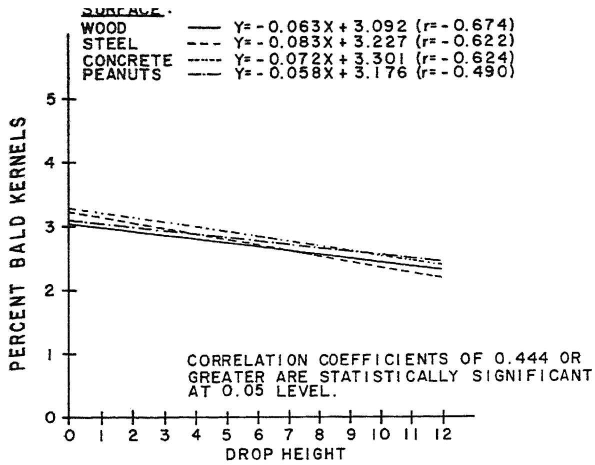
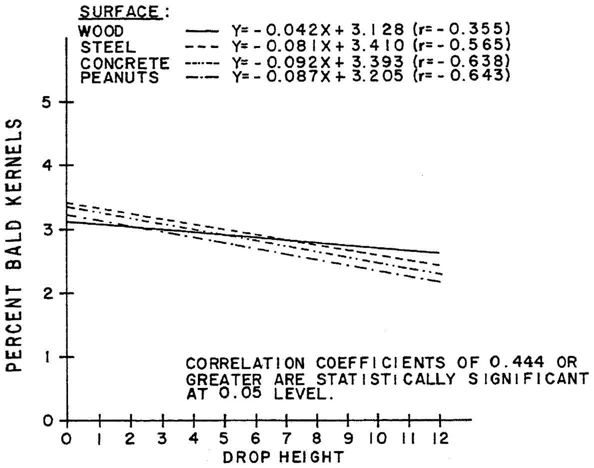


FIGURE 6.—Bald-kernel outturn of shelled 'Florunner' peanuts at 35° F after falling from various heights upon different surfaces.



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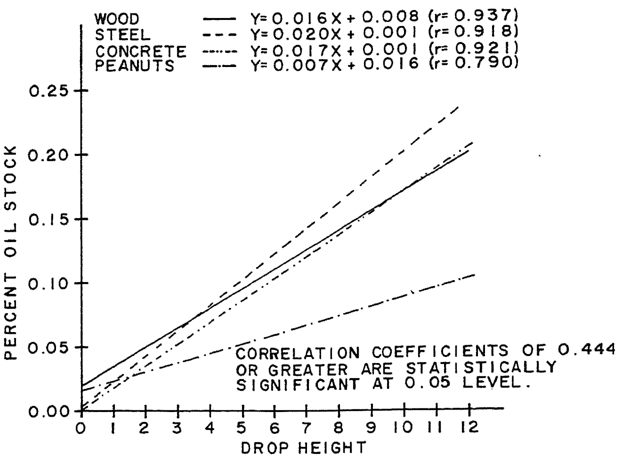
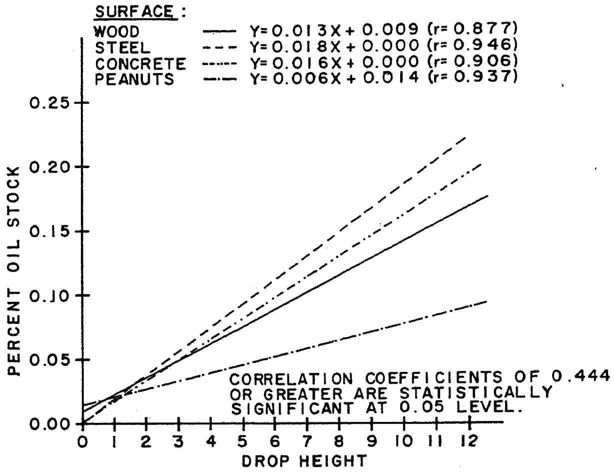


FIGURE 8.—Oil-stock outturn of shelled 'Florunner' peanuts at 35° F after falling from various heights upon different surfaces.



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This result was not expected, since in some tests peanut-impact velocities reached 27 feet per second. The control samples had 65 percent germination, and 33 percent of the peanuts were molded. The test samples varied within a few percentage points of the control samples, so perhaps the low germination and high incidence of mold masked or affected some of the damage results.

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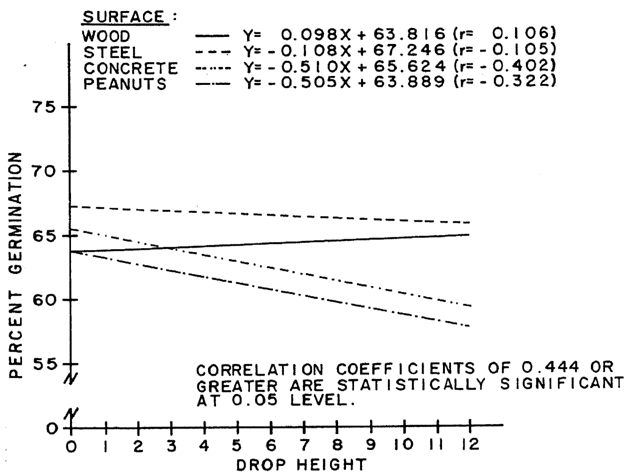

FIGURE 10.—Germination outturn of shelled 'Florunner' peanuts at 35° F after falling from various heights upon different surfaces.

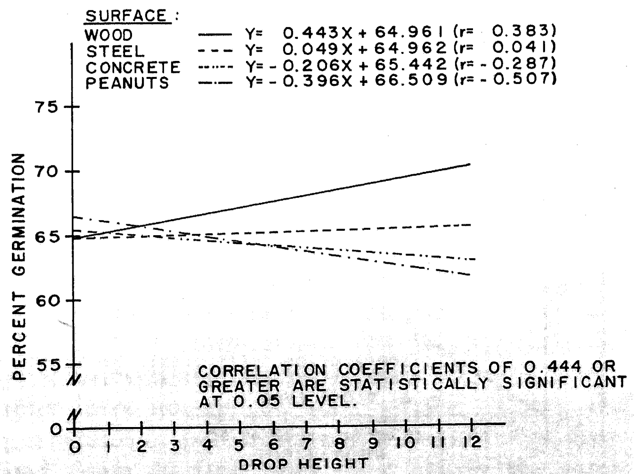

FIGURE 11.—Germination outturn of shelled 'Florunner' peanuts at 74° F after falling from various heights upon different surfaces.

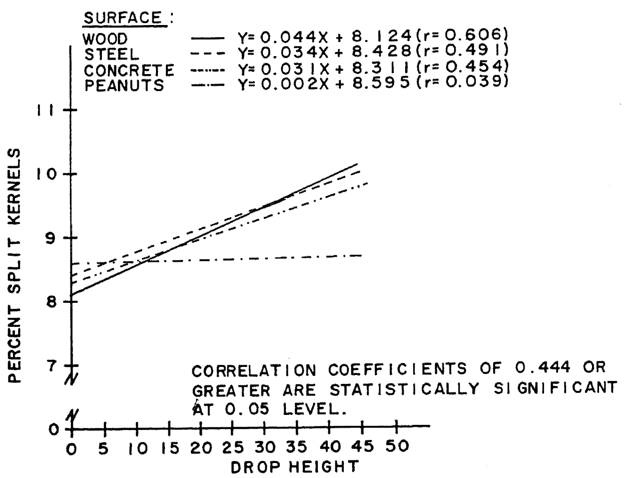

FIGURE 12.—Split-kernel outturn of inshell 'Florunner' peanuts at 76° F after falling from various heights upon different surfaces.

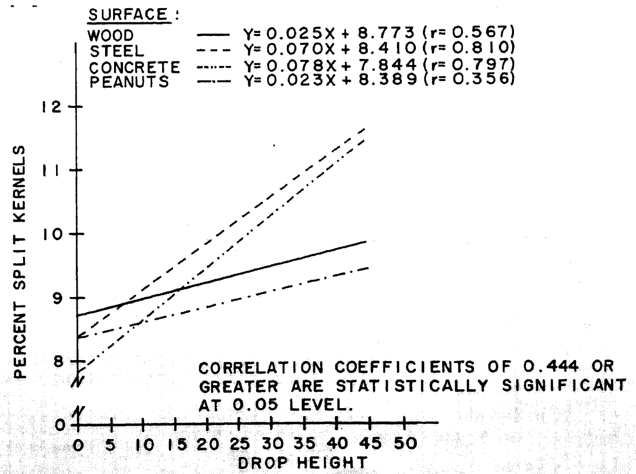

FIGURE 13.—Split-kernel outturn of inshell 'Florunner' peanuts at 35° F after falling from various heights upon different surfaces.

temperatures the impact of peanuts on peanuts caused fewer split kernels than the impact of peanuts on other surfaces. The peanuts at 35° F were particularly sensitive to the steel and concrete surfaces. In all cases split-kernel damage was significant, except for peanuts at 76° F impacted upon peanut surfaces. With peanuts at ambient temperature, the ability of the peanut surface to cushion and absorb impact forces was evident.

Loose shelled kernels

The peanuts were most sensitive to drop height, although impact surface and peanut temperature were significant causes of damage. The response of the peanuts to impact surface was

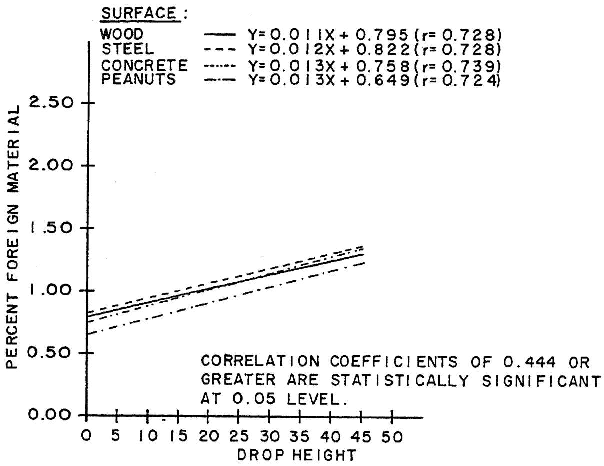

FIGURE 14.—Loose-shelled-kernel outturn of inshell 'Florunner' peanuts at 35° F after falling from various heights upon different surfaces.

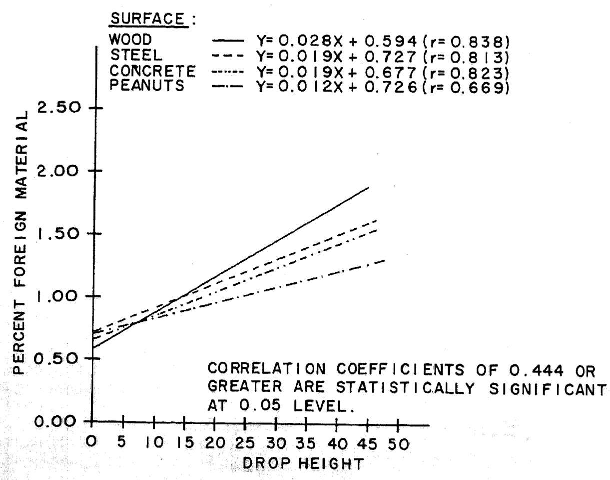

FIGURE 15.—Loose-shelled-kernel outturn of inshell 'Florunner' peanuts at 76° F after falling from various heights upon different surfaces.

very similar at both peanut temperatures, but the peanuts at 35° F had more damage than the peanuts at 76° F (figs. 14 and 15). At a given temperature, the wood, concrete, and steel surfaces caused very nearly the same amount of peanut damage and, in each case, more damage than was caused by the peanut surface.

Foreign material

There was some difference in the reaction of the two temperature groups of peanuts to drop height and impact surface. The peanuts at 76° F showed very little difference in response to impact surface (fig. 16), but damage gradually increased as drop height increased. The peanuts at 35° F showed a much more varied response

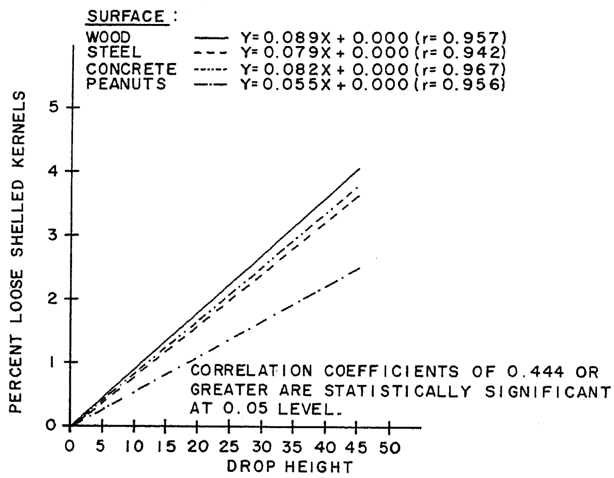

FIGURE 16.—Foreign-material outturn of inshell 'Florunner' peanuts at 76° F after falling from various heights upon different surfaces.

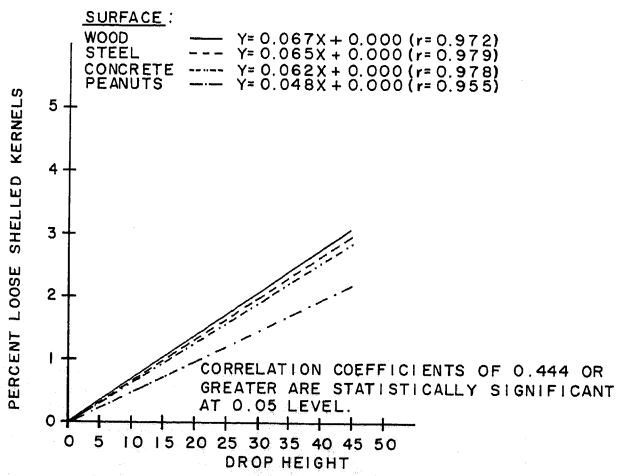

FIGURE 17.—Foreign-material outturn of inshell 'Florunner' peanuts at 35° F after falling from various heights upon different surfaces.

to impact surface (fig. 17), and damage increased more rapidly in response to drop height. The higher damage values for the peanuts at 35° F are indicative of the effect of peanut temperature. There was generally less damage with the peanut impact surface at both temperatures than with the other surfaces.

Cracked and broken pods

The response of the peanuts to the peanut impact surface for this type of damage was not the same as for the other damage categories. The amount of damage was equal to or more than that of the other surfaces at both temperatures. With the peanut impact surface, the peanuts did not bounce upon impact, as they did with the other impact surfaces, and thus were subjected to double impact, which may account for these results.

The peanuts at 35° F showed an almost total incidence of cracked and broken pods at the 45-foot drop height (fig. 18). The peanuts at 76° F were a little lower in percentage of breakage at the 45-foot drop height, but the initial percentage of broken pods was also lower (fig. 19). These results indicate some effect of temperature, but the difference is small and almost negligible.

The increase in percentage of cracked and broken pods was higher than the increase of any other damage factor. Losses from this type of damage are not directly measurable, but the potential loss is evident. Dirt and mold contamination are much more likely to occur, and insects have much easier access to kernels with cracked and broken pods. Also, loose shelled kernels are more likely to occur in future handling operations. There are many reasons to be concerned with this type of damage, but most importantly, if it does occur, a higher incidence of other types of damage is very probable.

Germination

Germination of the peanuts was very inconsistent, and the cause is not readily apparent. The control samples and test samples had low germination and high incidence of mold, which may have masked or affected the results. The germination percentages for all samples dropped from 45 feet were very nearly the same. These results were not as expected, since the velocity of the peanuts at impact was approaching 50 feet per second.

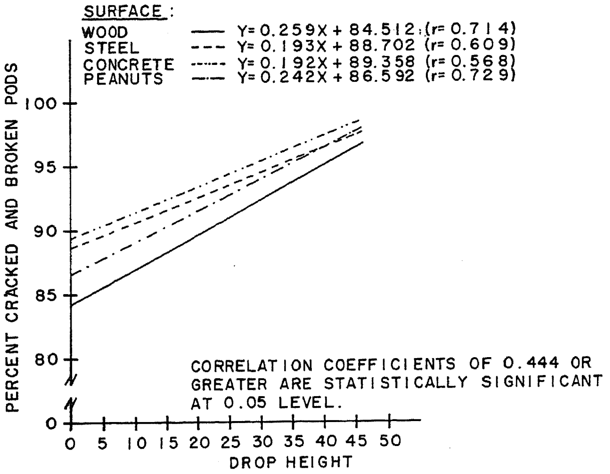

FIGURE 18.—Cracked- and broken-pod outturn of inshell 'Florunner' peanuts at 35° F after falling from various heights upon different surfaces.

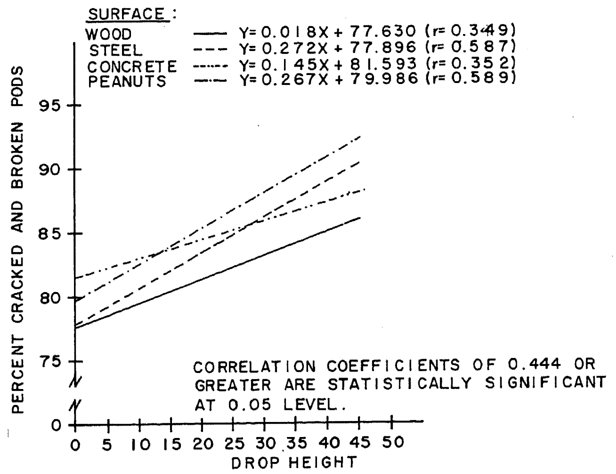

FIGURE 19.—Cracked- and broken-pod outturn of inshell 'Florunner' peanuts at 76° F after falling from various heights upon different surfaces.

The germination tests were run in accordance with procedures prescribed by the Georgia State Seed Testing Laboratory. However, it seems likely that some unknown factor affected the results; therefore, the data are not included in this report.

DISCUSSION

The results of these tests indicate that peanuts, particularly while in the shell, can withstand rather severe impact forces. In most of the test conditions the amount of damage was relatively low, particularly at the low and medium drop heights, which produced impact forces presum-

ably nearer those that peanuts would normally encounter.

There is no available history on prior handling of the peanuts used in these tests, but it is assumed that they were subjected to normal handling conditions. The grade factors of the control samples generally indicate that this is a fair assumption. However, most of the types of damage discussed here are accumulative and, depending on the frequency and severity of handling, could be much more severe.

The peanuts at 35° F had consistently higher damage values than those at 76° F. These results support the assumption that peanuts lose resiliency and are more easily damaged as they become colder.

Drop height was obviously the most critical cause of damage, and the statistical treatment of the test data shows its interaction with impact surface. The tests indicate that any hard surface that lacks resiliency will probably produce similar results. The consistently lower damage values (except those for cracked and broken pods) for the peanut impact surface supports such an assumption. Therefore, it follows that a resilient material should be used at all points where peanuts are subjected to free-fall impact. Also, impact damage should be eliminated by using letdown mechanisms and by operating equipment at slower speeds.

ACKNOWLEDGMENTS

This work was conducted under the general supervision of Reed S. Hutchison, research leader, National Peanut Research Laboratory, Agricultural Research Service, U.S. Department of Agriculture, Dawson, Ga.

The author expresses thanks to William G. Ferguson, industrial engineering technician, and Larry S. Creel, commodity grader, for technical assistance in conducting the study and to Victor Chew, mathematical statistician, Agricultural Research Service, U.S. Department of Agriculture, Gainesville, Fla., for suggestions on statistical treatment of the data.

APPENDIX.—DAMAGE EQUATIONS FOR SPANISH AND VIRGINIA PEANUTS

TABLE A–1.—*Equations for determining the percentage of damage to shelled 'Argentine' Spanish peanuts at 74° to 76° F when dropped upon different surfaces*[1]

Damage factor	Impact surface							
	Wood		Steel		Concrete		Peanuts	
	Equation	r	Equation	r	Equation	r	Equation	r
Oil stock	$Y=0.02X+0.08$	0.91	$Y=0.02X+0.06$	0.83	$Y=0.02X+0.07$	0.82	$Y=0.01X+0.06$	0.84
Split kernels	$Y=0.45X+0.44$	.97	$Y=0.41X+0.47$	.90	$Y=0.47X+0.13$	.94	$Y=0.29X+0.51$	.96
Bald kernels	$Y=0.08X+1.03$	.75	$Y=0.03X+1.25$	.22	$Y=0.08X+1.03$	.70	$Y=0.05X+0.91$	.51
Germination	$Y=0.28X+88.90$	.33	$Y=0.07X+79.73$	.03	$Y=-1.10X+83.50$	−.54	$Y=0.52X+87.06$	.37

[1] Drop-height values up to 12 feet may be substituted for X.

TABLE A–2.—*Equations for determining the percentage of damage to shelled 'Spancross' Spanish peanuts at 74° to 76° F when dropped upon different surfaces*[1]

Damage factor	Impact surface							
	Wood		Steel		Concrete		Peanuts	
	Equation	r	Equation	r	Equation	r	Equation	r
Oil stock	$Y=0.02X+0.05$	0.96	$Y=0.03X+0.03$	0.86	$Y=0.02X+0.06$	0.93	$Y=0.01X+0.07$	0.81
Split kernels	$Y=0.40X+0.45$	.93	$Y=0.41X+0.50$	.96	$Y=0.40X+0.38$	.94	$Y=0.21X+0.72$	.93
Bald kernels	$Y=0.19X+1.04$	.79	$Y=0.10X+1.26$	.77	$Y=0.17X+1.10$	.87	$Y=0.11X+1.21$	.78
Germination	$Y=-0.07X+97.45$	−.24	$Y=0.04X+97.09$	.21	$Y=0.10X+96.91$	.35	$Y=0.15X+96.72$	.62

[1] Drop-height values up to 12 feet may be substituted for X.

TABLE A–3.—*Equations for determining the percentage of damage to shelled 'Tifspan' Spanish peanuts at 74° to 76° F when dropped upon different surfaces*[1]

Damage factor	Impact surface							
	Wood		Steel		Concrete		Peanuts	
	Equation	r	Equation	r	Equation	r	Equation	r
Oil stock	$Y=0.01X+0.05$	0.88	$Y=0.01X+0.06$	0.77	$Y=0.01X+0.04$	0.86	$Y=0.01X+0.04$	0.78
Split kernels	$Y=0.28X+0.48$	.89	$Y=0.22X+0.56$	.88	$Y=0.24X+0.47$	.90	$Y=0.11X+0.70$	.77
Bald kernels	$Y=-0.06X+2.09$	−.16	$Y=-0.11X+2.08$	−.30	$Y=-0.06X+2.00$	−.16	$Y=-0.10X+2.01$	−.27
Germination	$Y=0.05X+92.19$	.06	$Y=0.13X+93.85$	.20	$Y=0.05X+94.40$	.16	$Y=-0.15X+95.08$	−.33

[1] Drop-height values up to 12 feet may be substituted for X.

TABLE A–4.—*Equations for determining the percentage of damage to shelled Virginia peanuts at 74° to 76° F when dropped upon different surfaces*[1]

Damage factor	Wood Equation	Wood r	Steel Equation	Steel r	Concrete Equation	Concrete r	Peanuts Equation	Peanuts r
Oil stock	$Y=0.03X+0.07$	0.94	$Y=0.04X+0.06$	0.93	$Y=0.03X+0.07$	0.92	$Y=0.02X+0.08$	0.77
Split kernels	$Y=1.71X+5.56$	.98	$Y=1.77X+6.69$	.99	$Y=1.70X+6.50$	.99	$Y=1.45X+6.86$	.98
Bald kernels	$Y=-0.83X+27.26$	−.90	$Y=-0.83X+28.25$	−.89	$Y=-0.73X+27.64$	−.91	$Y=-0.68X+27.73$	−.93
Germination	$Y=0.32X+65.48$	.30	$Y=0.27X+61.35$	.22	$Y=0.08X+62.00$	.07	$Y=-0.47X+64.38$	−.41

[1] Drop-height values up to 12 feet may be substituted for X.

TABLE A–5.—*Equations for determining the percentage of damage to shelled Virginia peanuts at 35° F when dropped upon different surfaces*[1]

Damage factor	Wood Equation	Wood r	Steel Equation	Steel r	Concrete Equation	Concrete r	Peanuts Equation	Peanuts r
Oil stock	$Y=0.01X+0.10$	0.78	$Y=0.02X+0.09$	0.91	$Y=0.01X+0.07$	0.85	$Y=0.01X+0.01$	0.82
Split kernels	$Y=0.86X+6.63$	.97	$Y=0.95X+6.91$	.97	$Y=0.92X+6.27$	.98	$Y=0.80X+7.21$	.97
Bald kernels	$Y=-0.50X+28.96$	−.87	$Y=-0.54X+28.34$	−.84	$Y=-0.58X+30.27$	−.77	$Y=-0.43X+29.06$	−.89
Germination	$Y=-0.29X+46.74$	−.23	$Y=-0.28X+48.69$	−.22	$Y=-0.52X+50.18$	−.34	$Y=0.61X+42.02$	.23

[1] Drop-height values up to 12 feet may be substituted for X.

TABLE A–6.—*Equations for determining the percentage of damage to inshell southeastern-grown Spanish peanuts at 74° to 76° F when dropped upon different surfaces*[1]

Damage factor[2]	Wood Equation	Wood r	Steel Equation	Steel r	Concrete Equation	Concrete r	Peanuts Equation	Peanuts r
FM	$Y=0.01X+1.76$	0.30	$Y=0.02X+1.63$	0.52	$Y=0.01X+1.59$	0.53	$Y=0.02X+1.49$	0.53
LSK	$Y=0.04X+-0.13$	.94	$Y=0.05X+-0.15$	.95	$Y=0.04X+-0.12$	.96	$Y=0.03X+-0.01$	.94
Split kernels	$Y=0.05X+2.99$	.71	$Y=0.11X+2.69$	.88	$Y=0.05X+2.87$	.78	$Y=0.08X+3.93$	.84
C&B pods	$Y=0.23X+47.93$	.47	$Y=0.53X+45.68$	.84	$Y=0.78X+44.15$	.91	$Y=0.41X+50.35$	.55
Germination	$Y=0.02X+88.44$	.11	$Y=-0.03X+89.78$	−.23	$Y=0.05X+87.61$	.22	$Y=-0.00X+89.62$	−.01

[1] Peanuts grown in southeastern region of United States. Drop-height values up to 45 feet may be substituted for X.
[2] FM, foreign material. LSK, loose shelled kernels. C&B pods, cracked and broken pods.

TABLE A-7.—*Equations for determining the percentage of damage to inshell southwestern-grown Spanish peanuts at 74° to 76° F when dropped upon different surfaces*[1]

Damage factor[2]	Impact surface							
	Wood		Steel		Concrete		Peanuts	
	Equation	r	Equation	r	Equation	r	Equation	r
FM	$Y=0.03X+0.48$	0.91	$Y=0.02X+0.61$	0.83	$Y=0.02X+0.65$	0.89	$Y=0.00X+0.90$	0.40
LSK	$Y=0.09X+-0.32$	.98	$Y=0.08X+-0.27$	.98	$Y=0.09X+-0.27$	.98	$Y=0.08X+-0.21$	.99
Split kernels	$Y=0.05X+11.14$	.57	$Y=0.06X+10.04$	.61	$Y=0.06X+9.71$	.71	$Y=0.07X+10.46$	.81
C&B pods	$Y=0.22X+81.62$	.67	$Y=0.34X+75.92$	.75	$Y=0.00X+82.70$	.91	$Y=0.24X+79.05$	.68
Germination	$Y=-0.01X+75.29$	−.02	$Y=-0.06X+78.24$	−.25	$Y=0.03X+75.03$	−.14	$Y=0.01X+74.98$	.03

[1] Peanuts grown in southwestern region of the United States. Drop-height values up to 45 feet may be substituted for X.
[2] FM, foreign material. LSK, loose shelled kernels. C&B pods, cracked and broken pods.

TABLE A-8.—*Equations for determining the percentage of damage to inshell southwestern-grown Spanish peanuts at 35° F when dropped upon different surfaces*[1]

Damage factor[2]	Impact surface							
	Wood		Steel		Concrete		Peanuts	
	Equation	r	Equation	r	Equation	r	Equation	r
FM	$Y=0.02X+0.63$	0.83	$Y=0.02X+0.62$	0.87	$Y=0.02X+0.62$	0.81	$Y=0.02X+0.54$	0.88
LSK	$Y=0.09X+-0.05$	.93	$Y=0.09X+-0.14$	.97	$Y=0.07X+-0.08$	.98	$Y=0.06X+0.07$	.93
Split kernels	$Y=0.10X+8.87$	.64	$Y=0.10X+8.72$	.69	$Y=0.06X+9.33$	.68	$Y=0.01X+9.49$	.13
C&B pods	$Y=0.32X+80.26$	.84	$Y=0.66X+69.18$	.88	$Y=0.18X+79.86$	.59	$Y=0.04X+74.74$	.18
Germination	$Y=-0.07X+77.77$	−.18	$Y=0.05X+77.43$	.22	$Y=-0.24X+75.50$	−.39	$Y=0.02X+76.68$	.04

[1] Peanuts grown in southwestern region of the United States. Drop-height values up to 45 feet may be substituted for X.
[2] FM, foreign material. LSK, loose shelled kernels. C&B pods, cracked and broken pods.

TABLE A–9.—*Equations for determining the percentage of damage to inshell Virginia peanuts at 74° to 76° F when dropped upon different surfaces*[1]

Damage factor[2]	Impact surface							
	Wood		Steel		Concrete		Peanuts	
	Equation	r	Equation	r	Equation	r	Equation	r
FM	$Y=0.01X+0.25$	0.72	$Y=0.01X+0.40$	0.45	$Y=0.01X+0.28$	0.76	$Y=0.01X+0.29$	0.51
LSK	$Y=0.02X+-0.02$	.96	$Y=0.02X+0.01$	.88	$Y=0.03X+-0.10$	.93	$Y=0.02X+-0.01$	.80
Split kernels	$Y=0.04X+5.20$	.46	$Y=0.01X+5.07$	.24	$Y=0.04X+5.06$	.56	$Y=0.03X+4.56$	.46
C&B pods	$Y=0.19X+80.73$	.72	$Y=0.17X+77.72$	.77	$Y=0.06X+78.70$	.35	$Y=0.16X+80.08$	.61
Germination	$Y=0.16X+59.17$	.34	$Y=0.33X+58.25$	.56	$Y=0.29X+50.60$	.63	$Y=0.15X+57.12$	.34

[1] Drop-height values up to 45 feet may be substituted for X.
[2] FM, foreign material. LSK, loose shelled kernels. C&B pods, cracked and broken pods.

TABLE A–10.—*Equations for determining the percentage of damage to inshell Virginia peanuts at 35° F when dropped upon different surfaces*[1]

Damage factor[2]	Impact surface							
	Wood		Steel		Concrete		Peanuts	
	Equation	r	Equation	r	Equation	r	Equation	r
FM	$Y=0.01X+0.32$	0.68	$Y=0.01X+0.39$	0.63	$Y=0.01X+0.33$	0.73	$Y=0.01X+0.37$	0.51
LSK	$Y=0.03X+-0.07$	.88	$Y=0.03X+-0.15$	.91	$Y=0.03X+-0.02$	.92	$Y=0.02X+0.03$	.86
Split kernels	$Y=0.08X+5.09$	.76	$Y=0.04X+5.65$	.45	$Y=0.07X+5.00$	.75	$Y=0.07X+5.00$	.72
C&B pods	$Y=0.29X+89.15$	.60	$Y=0.34X+85.58$	.76	$Y=0.20X+90.79$	.41	$Y=0.20X+90.07$	.44
Germination	$Y=0.08X+56.94$	.18	$Y=0.14X+58.59$	.30	$Y=0.15X+56.92$	.32	$Y=0.08X+58.52$	.17

[1] Drop-height values up to 45 feet may be substituted for X.
[2] FM, foreign material. LSK, loose shelled kernels. C&B pods, cracked and broken pods.

* 1976 G P O-1750-S-671-583/63